Appendix C

Engineering Report (Grading Permit Application)

$550 Filing Fee to be Attached

APPLICATION FOR EXCAVATING, GRADING, OR FILLING PERMIT

County of Marin
Department of Public Works
P.O. Box 4186
Room 304, Civic Center
San Rafael CA 94903-4186

August 20, 2002

415/499-3799

Re: Manure Pond Expansion
Barn Pad Expansion
Tim Kehoe, **Kehoe Dairy**
6150 Pierce Point Road
Inverness CA 94937

APN 109-040-001
415/669-1696

The undersigned hereby applies for approval to excavate, grade, or fill on land in unincorporated areas of the County of Marin by performing the following work: (Applicant will describe here fully what he wishes to do using reverse side or extra sheets, if necessary, and attach two copies of plans.)

Applicant's Attention is Directed to Section 23.08 of the Marin County Code

The work proposed involves construction of a milk cow barn pad (3800 cy) and a remote manure storage pond (13800 cy) and associated grading per the attached cover letter, design computations, and construction drawings.

Applicant agrees to do work in accordance with Marin County Code Section 23.08 and the rules and regulations of the Marin County Department of Public Works subject to its inspection and approval.

Marin County Area:_____

Excavation Permit Number:_____

Parcel No._____ Prepared by:_____
Plotted by: _____

Inspection fee, $:_____

Surety bond, $:_____

Permit Issue Date: _____

_____
Owner/Applicant Signature

Tim Kehoe
Kehoe Ranch
6150 Pierce Point Road
Inverness CA 94937
415/669-1696

Form EX04 3/78

Erickson Engineering Inc.
Valley Ford CA 94972-0446 707/795-2498 Voice/Fax

County of Marin
Department of Public Works
P.O. Box 4186 Room 304, Civic Center
San Rafael CA 94903-4186

August 20, 2002

415/499-3799

Attn: Grading and Drainage Review

Re: 13,800 cy embankment for 11 ac ft manure pond levee
3,400 cy pad for stall barn expansion
APN 109-040-001
415-663-1696

Tim Kehoe
Kehoe Dairy
6150 Pierce Point Road
Inverness CA 95437

Enclosed please find design and documentation material for the above referenced projects that are believed to conform to County standards. The work consists of earthwork cut and fill operations to construct: a) an earthfill embankment 0 – 20' high for an 11acre-foot capacity manure storage pond and b) level pads on either side of an existing dairy stall barn to allow enlargement of the structure. The work is located in Point Reyes National Seashore on a large rural parcel in the unincorporated area of Marin County. A summary of design criteria follows.

Grading Summary: The work sites will be cleared of grass and sod. Topsoil will be salvaged and stockpiled for placement over finished grade cut and fill surfaces. Compacted fill earthwork quantities are estimated at 3400 cy for the barn pads and 13,800 cy for the manure pond levee. Cut and fill volumes have been balanced on a project basis to avoid import or export of bulk materials. Certain infrastructure will be relocated or removed to accommodate the grading work, including but not limited to corral fences, existing concrete pads, feeders, fuel storage, an old barn, and a lean-to shed attached to the farm shop.

Resource Agency Reviews: The project sites are in upland off-channel areas. The barn pad expansion site is presently denuded dairy corrals for cows and calves. The manure pond site is a ridge crest pasture with introduced grasses, thistles, and other noxious weeds present. There are believed no habitat, channel, stream, riparian, fisheries, endangered species, wetlands, or other issues or conditions of concern to CDFG or other Resource Agencies at the separate locations. Existing infrastructure between barn and manure pond site consists of ranch roads with gully crossing, fences, and a surface-laid liquid transfer pipe line, none of which will be changed or affected by the site improvements.

Geologic Setting: The California Division of Mines and Geology map archives were consulted to evaluate the site geologic setting. The sites are characterized as being underlain by Pwg Pliocene-era (2 - 5 million years old) Wilson Grove formation (marine sandstone, conglomerate, tuff) bedrock.

The barn construction site is on the east flank of a gentle hilltop ridge crest at 0 – 15% slope, adjoining an area previously leveled for the existing barns. The manure pond site is on a ridge crest at 5 – 15% slope immediately downslope of an existing manure pond. Site topography, soil morphology, and existing cut and fill slopes at both sites is consistent with parent materials of siltstone - mudstone - sandstone and shale subjected to weathering and decomposition. There is no surficial evidence of seepage, soil creep, or landslide-type instability in the construction envelopes.

The geologic map resources do not indicate presence of any ancient fault lines at the contact of the various mapped soils units in the general vicinity. The geologically active San Andreas fault line is located in Tomales Bay, about 2 miles east of the site. The barn pad and manure pond sites could therefore be expected to undergo ground shaking during the lifetime of the project.

Possible earthquake effects include fault rupture, ground shaking, liquefaction, and lateral spreading or lurching. Since there are no known fault lines in the immediate work areas, fault rupture is unlikely. Liquefaction is most closely related to loose or saturated cohesionless soils undergoing ground shaking, and is considered of low probability at the sites due to the presence of moderately cohesive well-drained soils over relatively shallow decomposed bedrock with limited moisture present. The fill materials will be compacted to 90% ASTM D1557, and minor surface runoff will be routed around the sites, minimizing risk of presence of saturated or loose materials. Lateral spreading is related to movement of horizontal alluvial layers adjacent to an exposed face. Lurching is cracking or separation of soil parallel to unsupported cliff or stream banks. Since neither condition is present on site, potential of these conditions occurring is low.

Consistent with site grading activities for a remote agricultural facility, conservative design and construction criteria have been specified in lieu of detailed geotechnical analysis or characterization of site soils. By observation, the sandy loam topsoil and loam subsoils underlain at depth by durable fine-grained siltstone/sandstone are believed to be of moderate to low permeability, suitable for use as pad and embankment fill material. The existing manure storage pond has embankments up to 10' high with no observable seepage in or through the levee structure, providing anecdotal evidence of satisfactory low permeability for embankment construction. Soil plasticity is believed low, based on modest clay content and low level of shrinkage cracking in desiccated soils. Site cut and fill slopes have been specified at an industry standard of 2.0H:1V or flatter, considered conservative under all loading conditions. Specifications are in conformance with standard UBC requirements and minimize site footprint and earthwork requirements at these hillside locations. Topsoil salvage and removal of deleterious organic material is required. 90 percent relative compaction is specified for level lifts at optimum moisture content plus 3% on prepared subgrade to ensure fill integrity and to minimize permeability.

Soils: The USDA-NRCS Marin County Soil Survey Sheet 2 – (Tomales quadrangle) indicates the mapped soils units are #136 (Kehoe loam 9 - 15% slopes) on the uplands containing the work sites. The adjoining lowland areas outside the work area are located in a narrow valley between the work areas where the soils are categorized as #160 (Rodeo clay loam 2 – 5%).

136 – Kehoe Loam 9 - 15%: Per the soil survey, this deep, moderately well drained soil is on rolling uplands and was formed in material derived from sandstone. Slopes are smooth. A typical surface layer includes 36" of dark grayish brown loam classified ML. It is typically underlain by 12" pale to very pale brown fine sandy loam classified ML. Subsoils transition to weathered and decomposed sandstone encountered at about 4'. Bedrock occurs at greater depths and less weathering is observed at depth. Observation of local topography and the adjoining silage pit cut and fill slopes and existing manure pond cut and fill slopes is consistent with the USDA mapped soil units.

Permeability is expected to be moderate, with moderate water holding capacity. Plasticity is low to moderate with surface soil PI at non-plastic to10 and subsoil similarly classified. Corresponding liquid limit ranges are reported at 25 – 35. Runoff on unprotected slopes is expected to be rapid with moderate to high water erosion potential.

Barn Pad Hydrology: Rational Method procedures were used to estimate a 100-year design flow for surface runoff from the barn pad project site. The methodology of CalTrans District 4 was used, per the typical Marin County design approach.

Upslope tributary areas affecting the barn pad work site are relatively small due to constraining topography and the ridge crest location. Vegetated vee ditches and roof runoff controls will be used to the extent possible to divert clean runoff from the manure management system. The westerly pad is cut into native material and will essentially be covered by the barn roof extension. The easterly pad fill will be partially covered by the calf pen roof system. The remaining fill pad will be outsloped at 1% to promote diffuse sheet flow drainage away from structural improvements.

Rainfall values for the 100-year storm in various parts of the work area range from 1.8 to 4.8 inches, per the attached spreadsheet summary. Surface runoff from the uplands and from the vegetated cut slope will be by low-slope vegetated vee ditches per the attached spreadsheet Manning's Equation computations. A 6" – 8" vegetated vee ditch is satisfactory for all flow conditions per the attachments. Roof runoff will be managed using downspouts and directing flow to a 12" n=.012 culvert extension of the existing fresh water drainage system. The calf pen site runoff will be via diffuse sheet flow to downslope areas with permanent vegetation.

Manure Storage Pond Hydrology: Discharge of manured water from waste storage areas is not allowed, per State Water Quality Control Board regulation. System storage volume design criteria is therefore a function of regulatory requirements, annual rainfall totals, storm surcharge volumes, and manure produced within the system, rather than the traditional surface runoff hydrology associated with reservoir design. The manure storage pond is sized to retain the annual design volume without discharge. The pond therefore does not include a principal or emergency spillway and capacity is managed in a manner to prevent overtopping or discharge under all circumstances.

Capacity management includes creation of a storage volume consistent with regulatory requirements, minimizing clean water inputs into the management system, emptying all storage ponds via land application of liquids and solids at agronomic rates over wide areas prior to onset of winter rains, discharge of clean water from empty and clean storage areas until time of use in the rainfall season, and backup/contingency plans and hardware for land disposal of liquid and solid wastes on an as-needed basis throughout the year.

Required system storage capacity has been evaluated for foreseeable agricultural demands and factored into the present design. It includes containment of animal manure and manured surface runoff water for a 600+ cow facility based on site-specific information. Per State Water Code, it is designed to retain runoff for the 10-year wet winter and for the 25-year, 24-hour storm for the entire facility. Design values at this site include 24" average annual rainfall, 35.8" 10-year wet winter rainfall, and 3.6" rainfall for the 25-year 24-hour storm. Computations were completed using a spreadsheet format, which is attached.

The proposed waste storage pond has a water surface of about 1.33 acres at the design storage elevation, with an 11 acre-foot capacity. The structure is the last cell in a series of ponds with about 19 acre-feet total capacity, and therefore will remain unused for about half the rainfall season. During that time, clean rainwater will be discharged, increasing effective system capacity by about 1.3 ac x 1' = 1.3 acre feet relative to actual capacity. The 4+ acre foot pond immediately upstream will settle out any manure solids not already captured in the first 2+ acre-foot cell, so that the material stored in the last pond will be primarily liquid. Liquid can be disposed of by irrigation via an existing system, or by use of an on-site 4200 gallon tank truck for delivery to remote silage fields.

Erosion Controls: The plans and specifications require construction during the dry season, temporary geotextile fencing, seeding and mulching, and other appropriate measures used on an as-needed basis to prevent soil mobilization and sediment transport to downslope areas. Little erosion potential is expected in this moderate rainfall area with work completed during the dry season. Permanent erosion

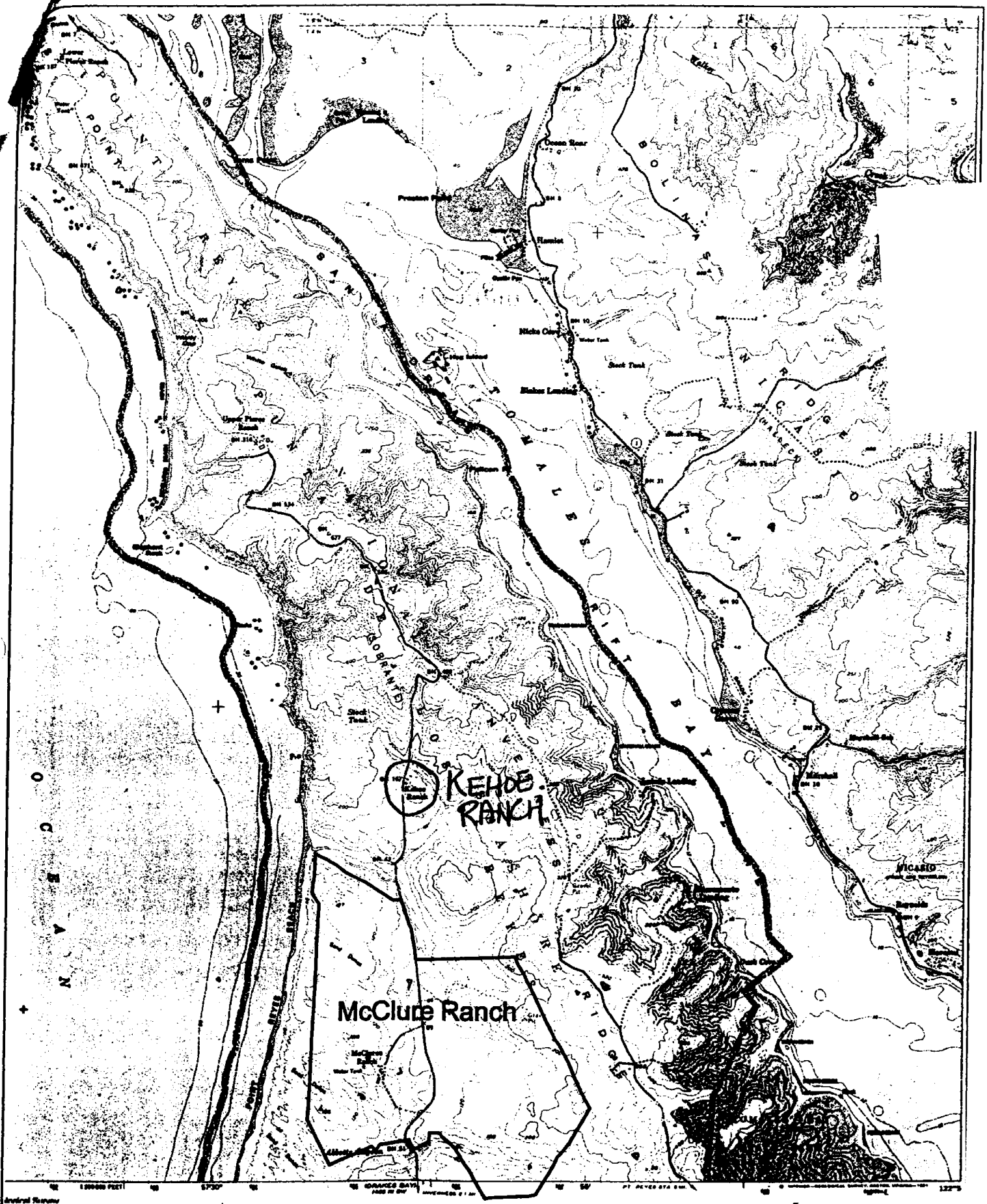
control measures include permanent cover crop conditions on embankments and within the developed hillside areas.

We trust that the narrative above and the enclosed design and construction materials provide satisfactory documentation of the work. Please call if you have comments or questions, or if additional materials are required.

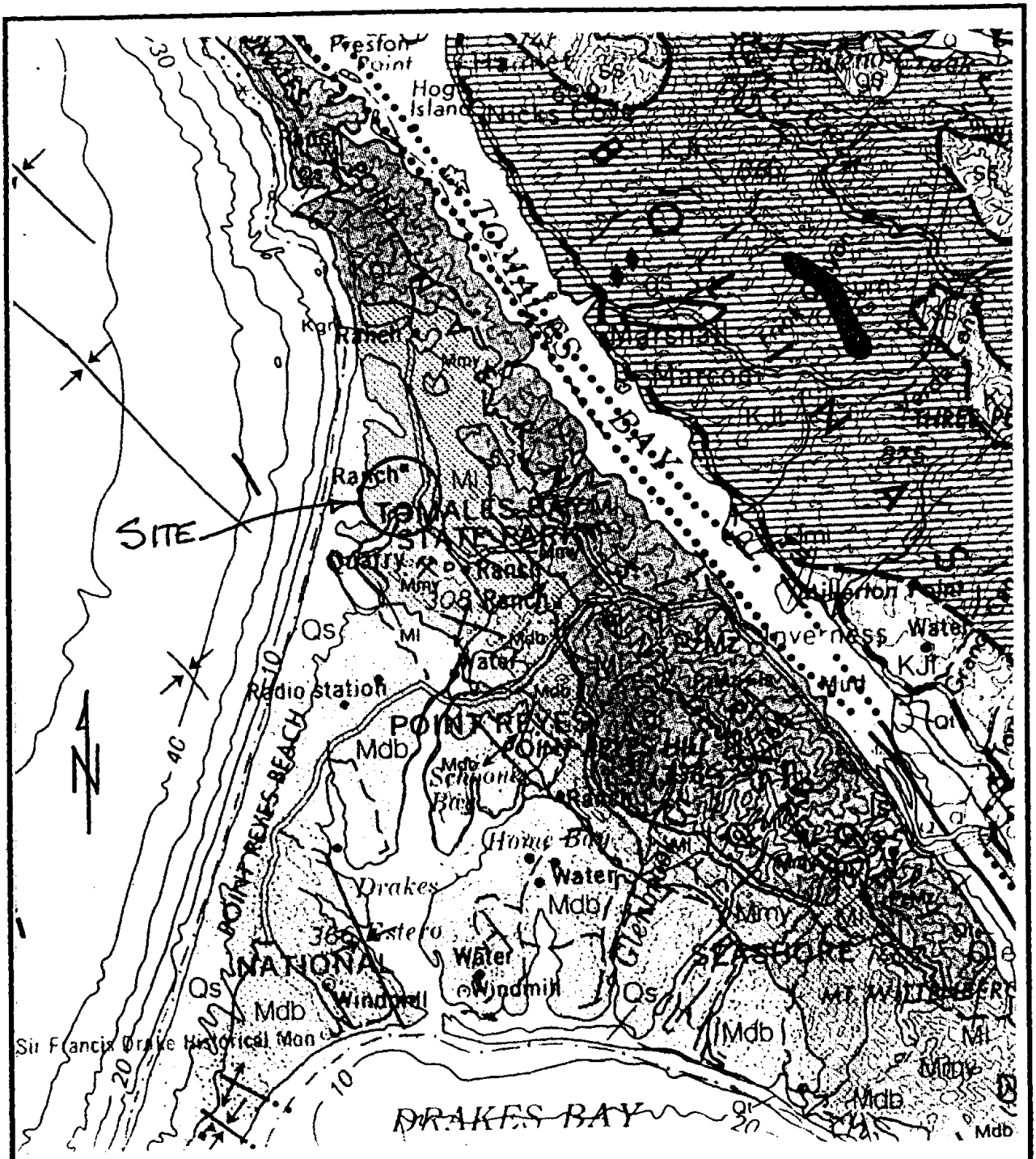
Very truly yours,

Lee Erickson, PhD CE45660 AE468
Civil and Agricultural Engineer

Enclosures: Plans, Engineering calculations
cc: Client
Whitmire Consulting



	DATE: January, 2001 SCALE: 1"= 4000' CHECKED BY: MN DRAFTED BY: EA	Point Reyes National Seashore Project Location Map on USGS Topo "Tomales"	Figure

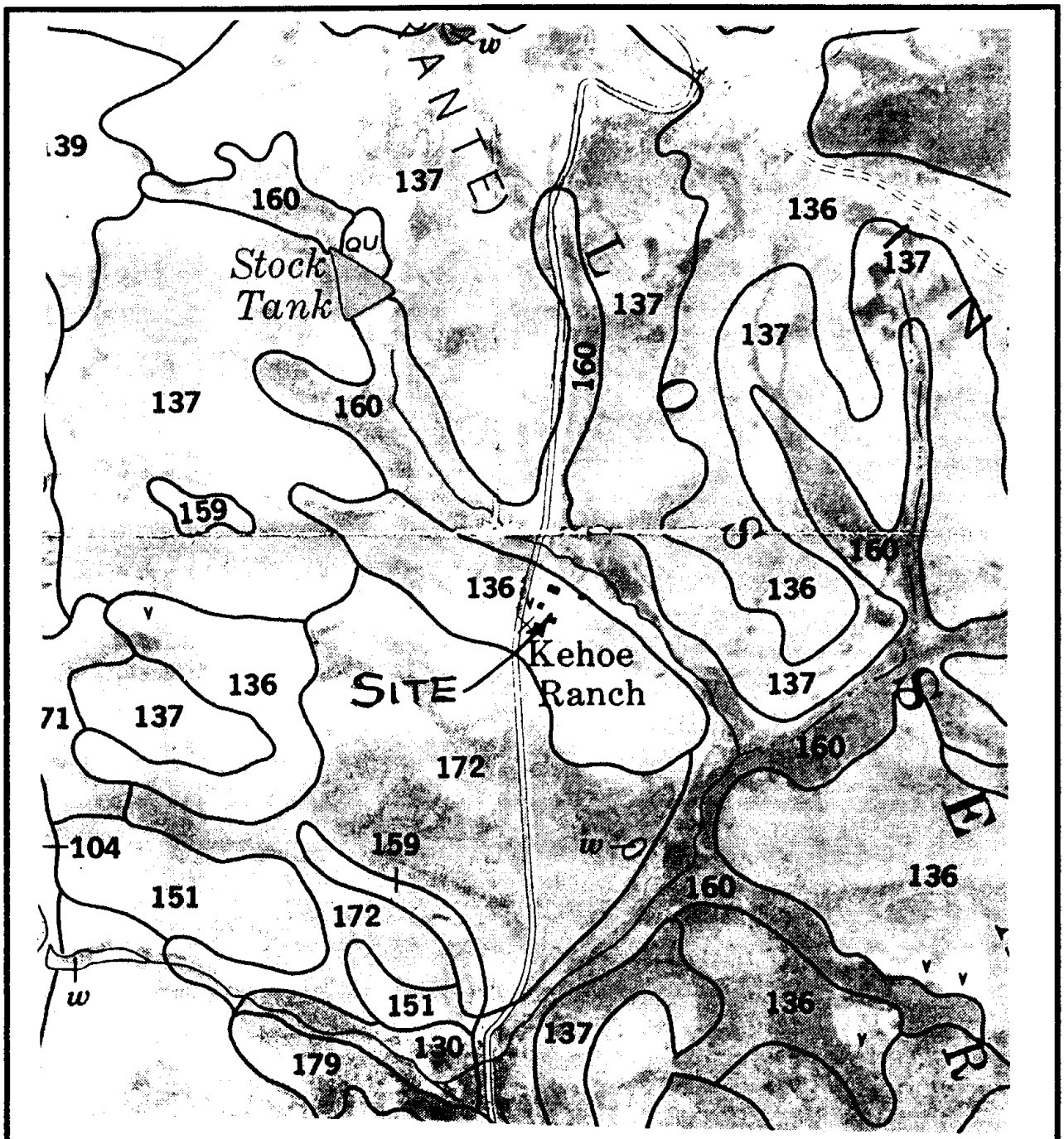


Ranch Barn Pad

- Geologic Setting

Erickson Engineering Inc.
Valley Ford CA 94972-0446
707/795-2498 Voice/Fax

Scale: 1:125,000 May 12, 2001
California Div. Mines, Geology
Santa Rosa Quad Map 2A - Geology

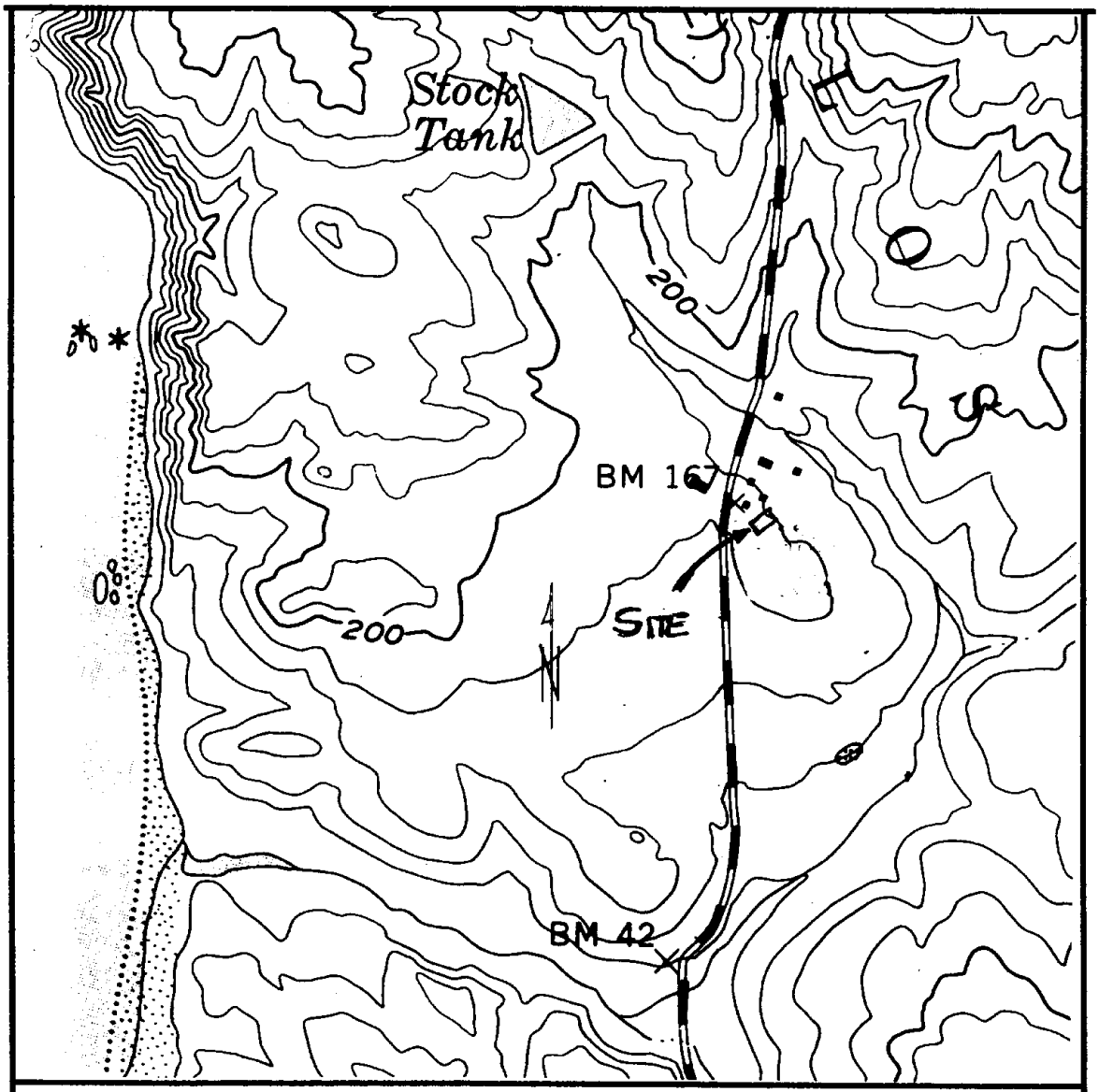


136: Uplands - Kehoe loam 9 – 15%
160: Lowlands – Rodeo clay loam 2 – 15%

Kehoe Dairy, Pierce Point Road, Inverness CA 95437
Soils per USDA SCS Marin County Soil Survey

Erickson Engineering Inc.
Valley Ford CA 94972-0446
707/795-2498 Voice/Fax

June 4, 2002
Map Sheet Tomales Point



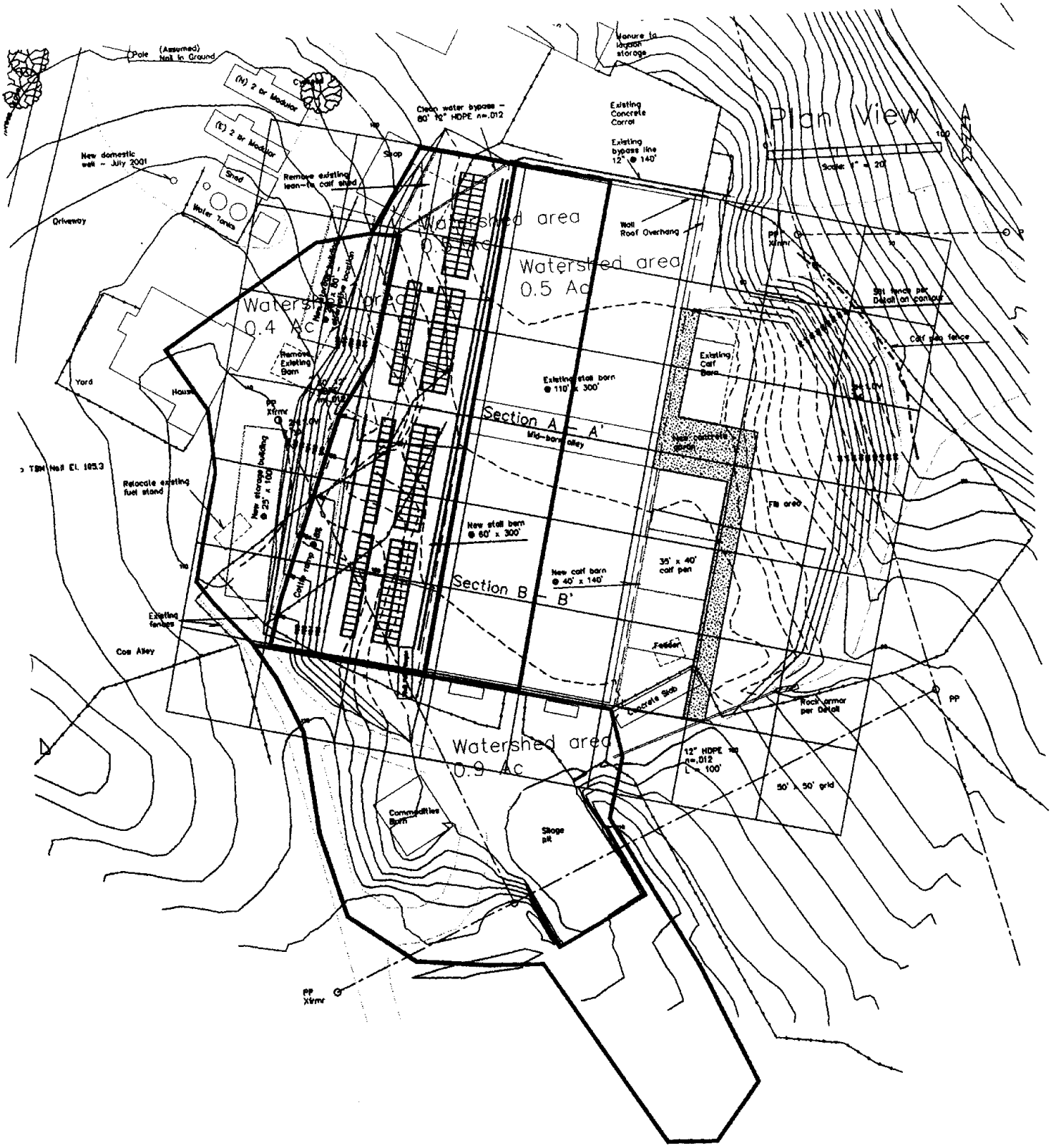
Location Sketch

USGS 7.5–min Quad map: Tomales
Scale: 1" = 1000' 20' Contours

Kehoe Dairy - Watershed Areas

Erickson Engineering Inc.
Valley Ford CA 94972-0446
707/795-2498 Voice/Fax

June 4, 2002
USGS 7.5min Map: Tomales
Scale: 1" = 1000' Contour Interval 20'


Plan View
Scale 1" = 20'
Watershed area
0.5 Ac
Watershed area
0.4 Ac
Watershed area
0.9 Ac
Section A – A'
Mid-barn alley
Section B – B'
Existing stall barn
@ 110' x 300'
New stall barn
@ 60' x 300'
New calf barn
@ 40' x 140'
35' x 40'
calf pen
Existing
Calf
Barn
Existing
Concrete
Corral
Manure to
lagoon
storage
Existing
bypass line
12" @ 140'
Clean water bypass –
60' 12" HDPE n=.012
Wall
Roof Overhang
Remove existing
lean-to calf shed
Remove
Existing
Barn
Shed
Water Tanks
Driveway
Yard
House
New domestic
well – July 2001
(M) 2 or Modular
(E) 2 br Modular
Relocate existing
fuel stand
New storage building
@ 25' x 100'
Cattle ramp
Existing
fences
Cow Alley
Feeder
Concrete Slab
Fill area
Rock armor
per Detail
12" HDPE
n=.012
L= 100'
50' x 50' grid
Commodities
Barn
Silage
pit
Calf pen fence
Silt fence per
Detail on contour
PP
Xfrmr
PP
Xfrmr
PP
Pole (Assumed)
Not in Ground
TBM Nail El. 105.3

Erickson Engineering Inc, Valley Ford CA 94972-0446

Marin County Hydrology
Kehoe Ranch
Barn Pad Grading/Drainage

File: xl2000/projects/kehoe/hydro
Time: 11:18 AM
Date: 05-Jun-02
Updated: 04-Jun-02

Methodology and references from Caltrans, District 4.

Design Rainfall Intensity, Map "I"
1-hour, 100-year isohyets
I-1,100 = 1.65 inches/hour

Design Rainfall Variations, Map V
Site is Zone A1
1.65 i in/hr

Runoff coefficient "c" = 1.0 for direct surface precip, no watershed area.
Runoff coefficient "c" = .45 for rural vegetated areas, slopes < 20%,
Calculate Time of Concentration Tc for each site Tc ={ [1.8*(1.1-c)*I^.5] / [s*(100)]^1/3 } + 5 min.

	c	Watershed Dimension L, ft.	delta H, ft.	Slope s, ft/ft	Tc, min.	Chart K I-1,100 iph
West hill and cut bank	0.45	150	12	0.080	40.4	1.8
Barn Roof (New Section)	1.00	60	6	0.100	7.8	4.8
Barn Roof (Old Section)	1.00	60	6	0.100	7.8	4.8
Silage to east swale	0.45	180	10	0.056	60.8	1.65

Use Chart "K" for Zone A to evalutate Intensity (in/hr) for use at each site.
Find chart curve using I-1,100 = 1.65 iph at Tc = 60 min.
Read I-1,100 for each site at Tc values in table above.

	c	Chart K I-1,100 iph	Topo map Acres	Q = c*i*A Q100 cfs	Q500/Q100 1.22 Q500 cfs	1000/Q100 1.33 Q1000 cfs
West hill and cut bank	0.45	1.8	0.4	0.3	0.4	0.4
Barn Roof (New Section)	1.00	4.8	0.4	2.0	2.4	2.6
Barn Roof (Old Section)	1.00	4.8	0.4	2.0	2.4	2.6
Cumulative Total for freshwater diversion, west side				4.3	5.2	5.7
Silage to east swale	0.45	1.65	0.9	0.7	0.8	0.9

From Chart K for (25 min < Tc <50 min), 10 vs 100 yr intensity ratio = .64-.65
From Frequency Distribution Ratio Chart "R", multipliers for various return periods may be found.
For R (10/100) = .64-.65, 500-yr = 1.22 x 100 yr.
For R (10/100) = .64-.65, 1000-yr = 1.33 x 100 yr.
For R (10/100) = .64-.65, 2000-yr = 1.43 x 100 yr.

Use Mannings Equation to evaluate minimum pipe sizes

Q100 used for design flows - Low Risk location
Agricultural facility

Mannings Equation, Circular section
Provides V, Q based on Diameter for given n, slope

West Side of Barn Q100 = 4.3 cfs
12" culvert System For roof gutters, Bypass Flows

Input Parameters		Output Parameters		
12.0 inch pipe diameter	H2O Depth d:	7.00 inches	0.58	ft at outlet
0.58 d/D ratio ← ok	Sector above H2O:	1.40 ft	2.09	Froude No.
0.012 Manning's n	Circumfrence:	3.14 ft	2.54	ft crit depth
0.030 s, channel slope ft/ft	theta:	2.81		
33.333 1/s, chl slope, ft/100 ft	Water area:	0.48 sq ft	0.79	pipe area
0.6 C, inlet coefficient	Wetted Perim:	1.74 ft		
	Hydraulic Radius:	0.27 ft	Inlet at pipe depth	
Provide rock riprap @ outfall → Short term Flow - ok	Outlet Velocity:	9.04 ft/sec	CA(2gd)^.5	
	Outlet Flow Rate:	4.30 cfs	3.78	cfs inlet
Outfall Parameters	Max Outfall Time:	0.86 sec; (2D/g)^.5		
	Max/Actual Transition Distances:	7.80 ft; V(t)	4.55	ft; V(t)

Mannings Equation, Trapezoidal Sections
Reference Brater and King, Chapter 7

Vee DitchW side of Barn Q100 = .3 cfs
Cow ramp area
Vegetated ok

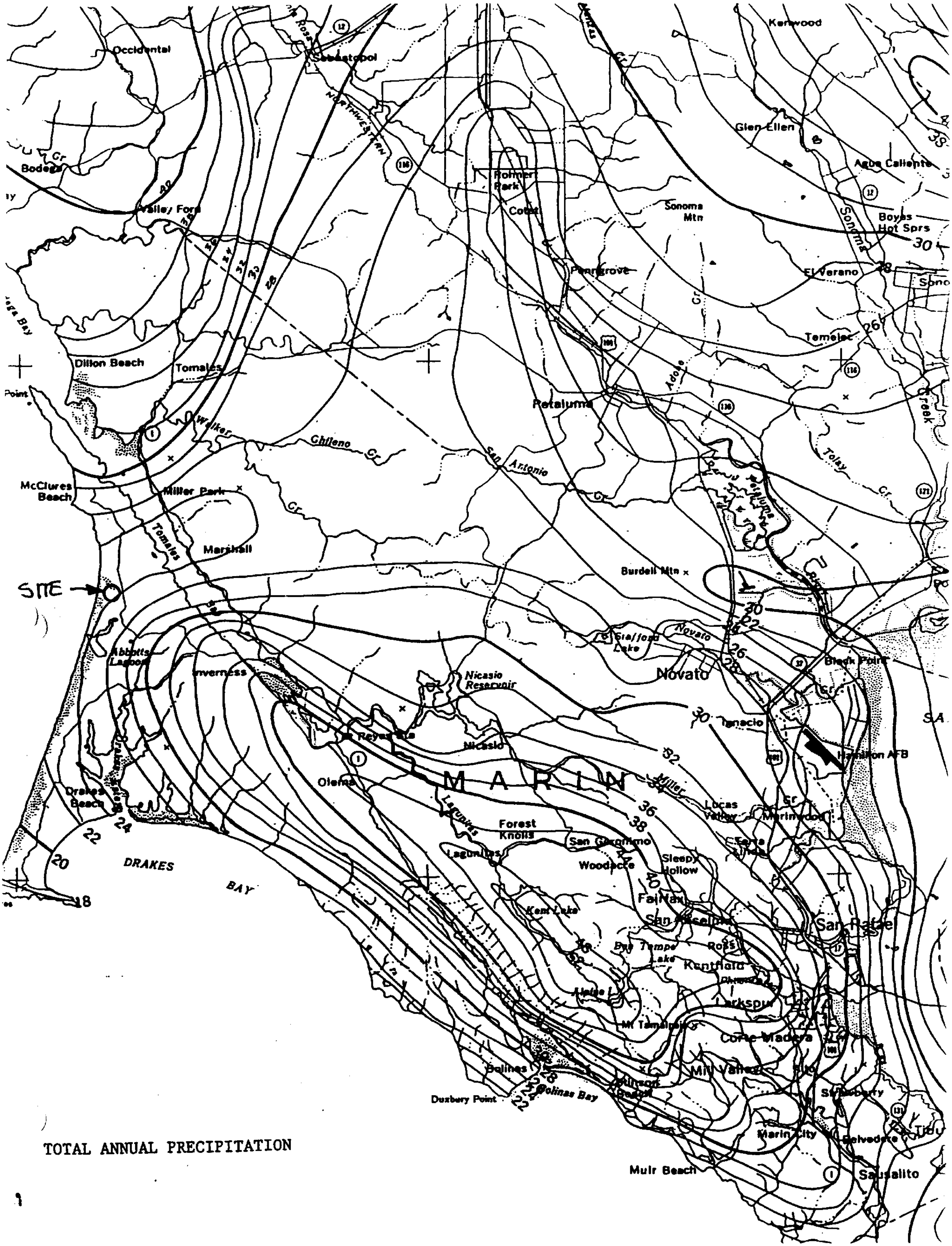
Input Parameters		Output Parameters		
0.15	Normal depth, ft	0.30 cu ft/sec	Flow capacity	
0.035	Manning's n	2.59 Ft/sec	Velocity	non-erosive
0.080	s, channel slope ft/ft (Ramp Slope)	0.12 Sq Ft	Area	ok
12.50	1/s, channel slope, ft/100ft	1.08 Ft	Topwidth	
2.0	Z, side slope, ft/ft	0.10 Ft	Velocity Head	
0.5	b, bottom width, ft	0.25 Ft	Energy Head	
		1.20 V/(gd)^.5	Froude #:	Supercrit

Mannings Equation, Circular section
Provides V, Q based on Diameter for given n, slope

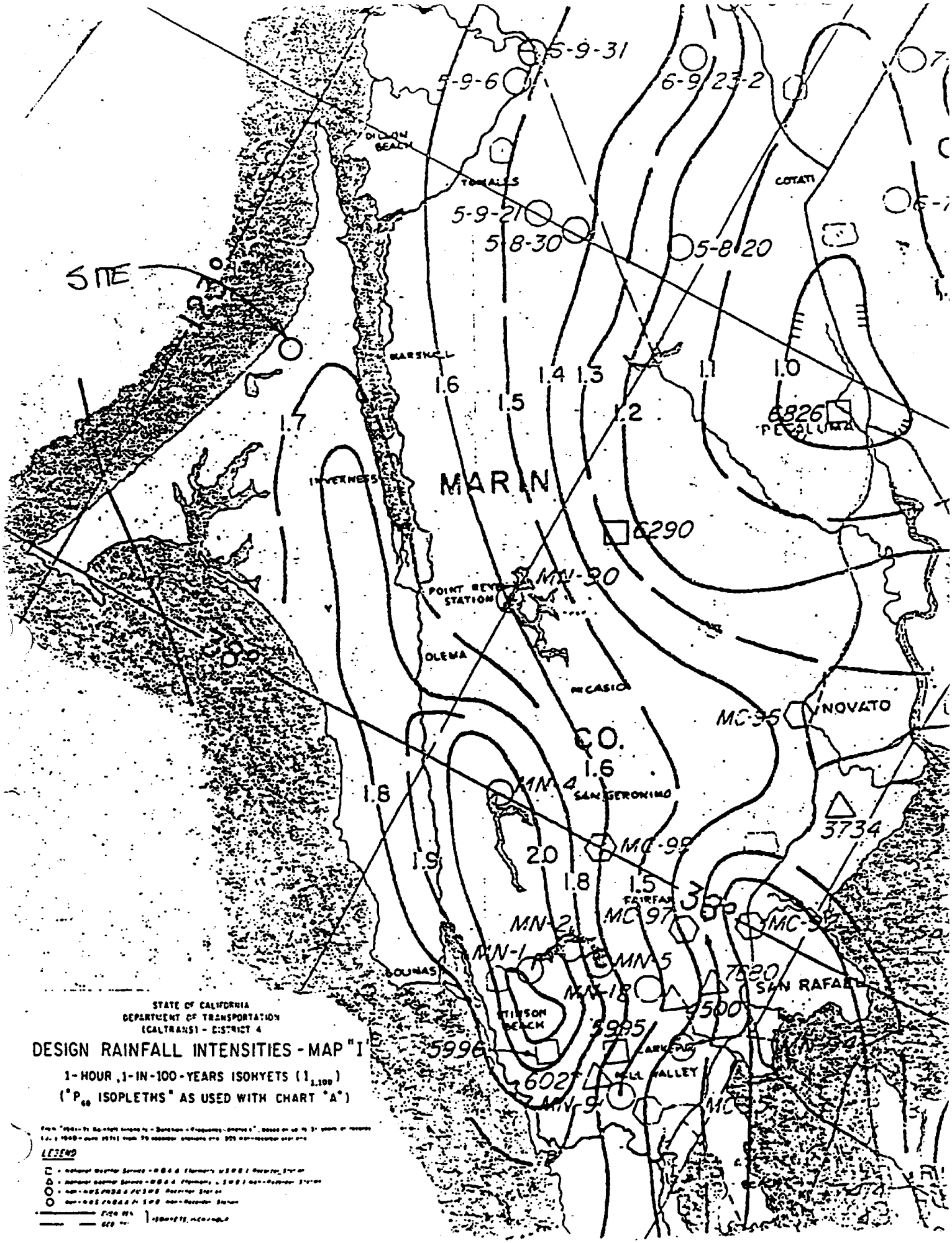
East side culvert Q100 = 0.7 cfs
under/around new calf pens

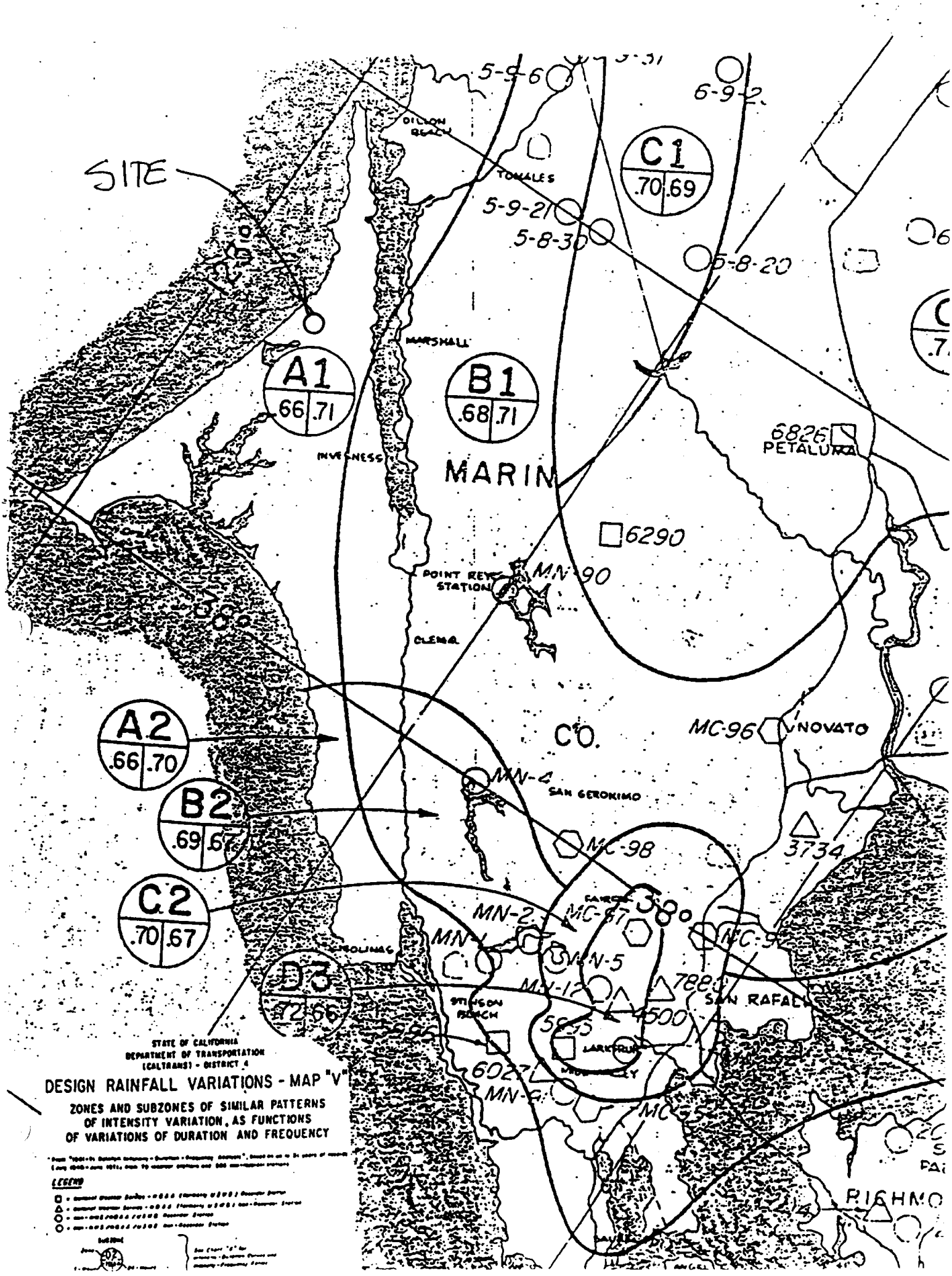
Input Parameters		Output Parameters		
12.0 inch pipe diameter	H2O Depth d:	2.62 inches	0.22	ft at outlet
0.22 d/D ratio ok	Sector above H2O:	2.17 ft	2.08	Froude No.
0.012 Manning's n	Circumfrence:	3.14 ft	0.95	ft crit depth
0.030 s, channel slope ft/ft	theta:	4.34		
33.333 1/s, chl slope, ft/100 ft	Water area:	0.13 sq ft	0.79	pipe area
0.6 C, inlet coefficient	Wetted Perim:	0.97 ft		
	Hydraulic Radius:	0.13 ft	Inlet at pipe depth	
Rock armor @ outfall per detail →	Outlet Velocity:	5.52 ft/sec ok	CA(2gd)^.5	
	Outlet Flow Rate:	0.70 cfs	3.78	cfs inlet
Outfall Parameters	Max Outfall Time:	0.86 sec; (2D/g)^.5		
	Max/Actual Transition Distances:	4.76 ft; V(t)	1.04	ft; V(t)

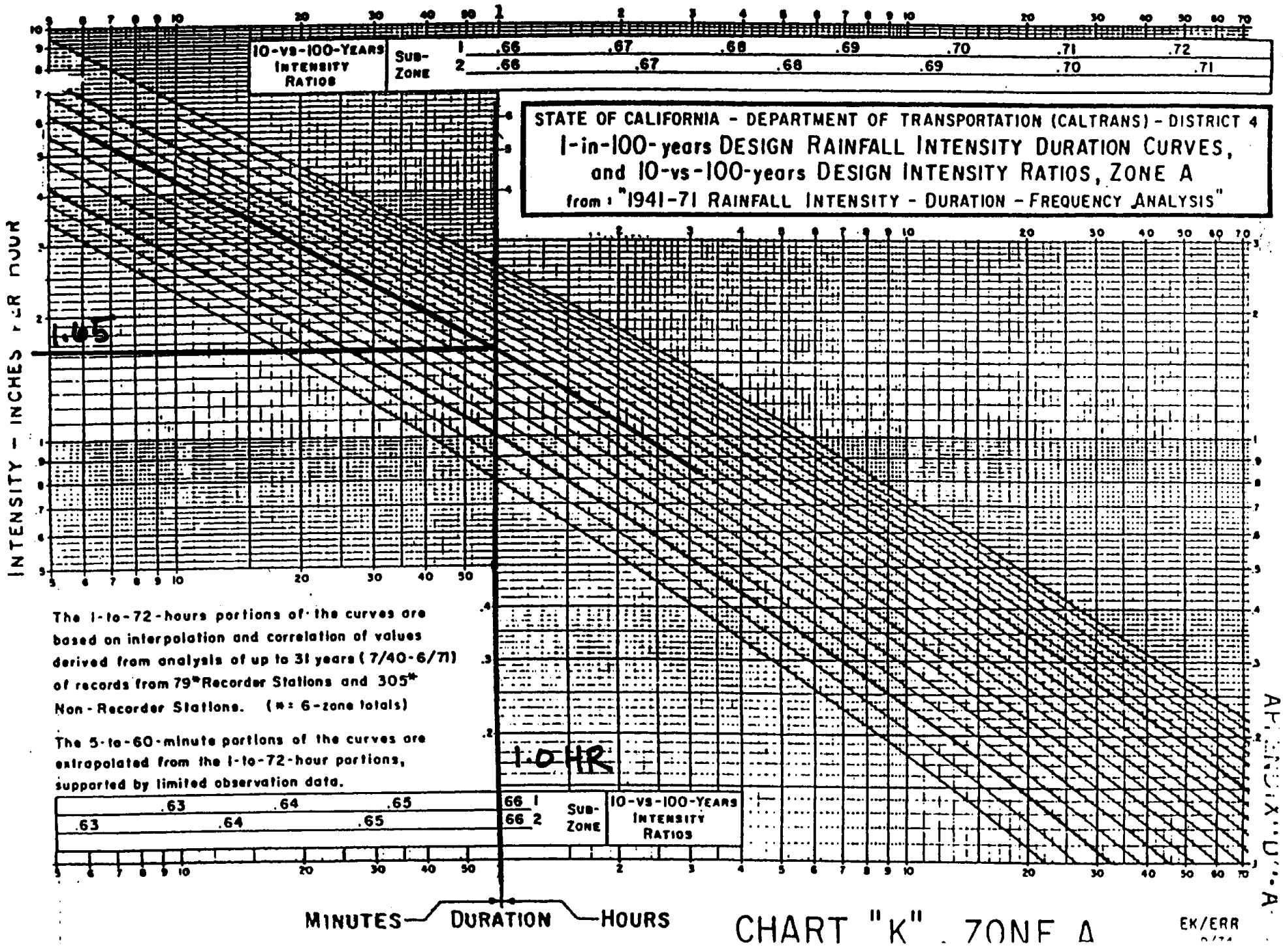
12" Lines used to accomodate potential debris, maintain excess capacity



TOTAL ANNUAL PRECIPITATION


5-9-31
5-9-6
6-9-23-2
DILLON BEACH
TOMALES
COTATI
5-9-21
5-8-30
5-8-20
SITE
MARSHALL
1.6
1.5
1.4
1.3
1.2
1.1
1.0
1.7
6826
PETALUMA
INVERNESS
MARIN
6290
MN-30
POINT REYES STATION
OLEMA
NICASIO
MC-35
NOVATO
CO.
1.6
1.8
MN-4
SAN GERONIMO
3734
MC-99
2.0
1.9
1.8
1.5
FAIRFAX
MC-97
MC-3
MN-2
MN-1
MN-5
MN-18
7820
SAN RAFAEL
BOLINAS
STINSON BEACH
5995
5996
9500
602
MILL VALLEY
MN-9
MC-5
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
(CALTRANS) - DISTRICT 4
DESIGN RAINFALL INTENSITIES - MAP "I"
1-HOUR, 1-IN-100-YEARS ISOHYETS ($I_{1,100}$)
("P_{60} ISOPLETHS" AS USED WITH CHART "A")
LEGEND

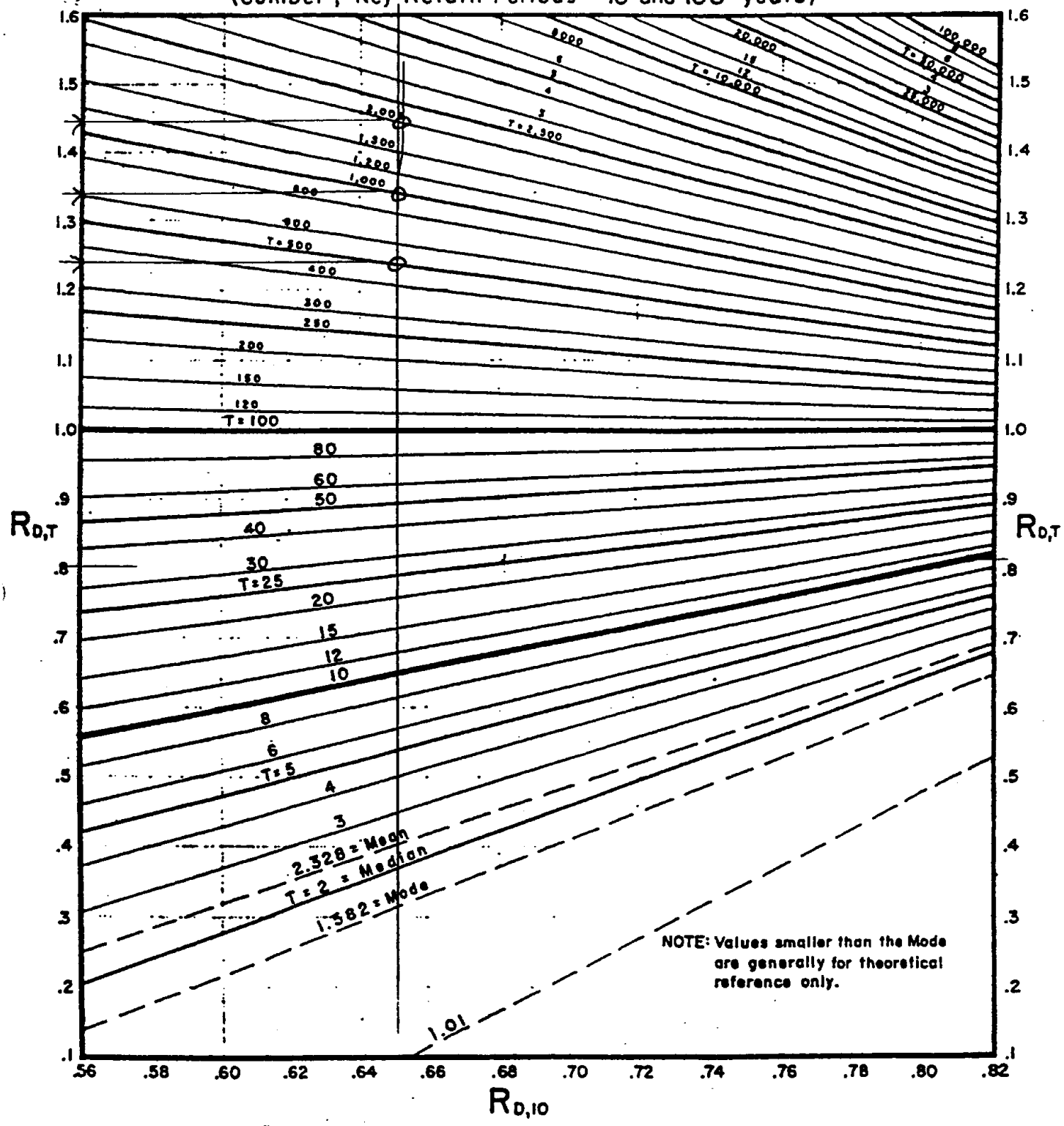

SITE
A1
.66 .71
B1
.68 .71
C1
.70 .69
A2
.66 .70
B2
.69 .67
C2
.70 .67
D3
.72 .66
MARIN
CO.
MARSHALL
INVERNESS
POINT REYES STATION
OLEMA
TOMALES
DILLON BEACH
PETALUMA
6826
6290
MN-90
MC-96
NOVATO
MN-4
SAN GEROKIMO
MC-98
3734
MN-2
MC-87
MN-5
MN-12
7880
SAN RAFAEL
4500
5855
6027
STINSON BEACH
LARKSPUR
RICHMO
5-9-6
6-9-2
5-9-21
5-8-30
5-8-20
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
(CALTRANS) - DISTRICT 4
DESIGN RAINFALL VARIATIONS - MAP "V"
ZONES AND SUBZONES OF SIMILAR PATTERNS
OF INTENSITY VARIATION, AS FUNCTIONS
OF VARIATIONS OF DURATION AND FREQUENCY
LEGEND


10-VS-100-YEARS INTENSITY RATIOS
SUB-ZONE
1 .66 .67 .68 .69 .70 .71 .72
2 .66 .67 .68 .69 .70 .71
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION (CALTRANS) - DISTRICT 4
1-in-100-years DESIGN RAINFALL INTENSITY DURATION CURVES,
and 10-vs-100-years DESIGN INTENSITY RATIOS, ZONE A
from: "1941-71 RAINFALL INTENSITY - DURATION - FREQUENCY ANALYSIS"
INTENSITY - INCHES PER HOUR
1.65
1.0 HR
The 1-to-72-hours portions of the curves are based on interpolation and correlation of values derived from analysis of up to 31 years (7/40-6/71) of records from 79* Recorder Stations and 305* Non-Recorder Stations. (*= 6-zone totals)
The 5-to-60-minute portions of the curves are extrapolated from the 1-to-72-hour portions, supported by limited observation data.
.63 .64 .65
.63 .64 .65
66 1
66 2
SUB-ZONE
10-VS-100-YEARS INTENSITY RATIOS
MINUTES
DURATION
HOURS
CHART "K" ZONE A
EK/ERR
APPENDIX "A"

STATE OF CALIFORNIA – DEPARTMENT OF TRANSPORTATION (CALTRANS) – DISTRICT 4

FREQUENCY DISTRIBUTION RATIOS CHART "R"

(Gumbel ; Key Return Periods = 10 and 100 years)



EQUATIONS SEE "1941-71 RAINFALL INTENSITY-DURATION-FREQUENCY ANALYSIS"

(29) $R_{D,T} = I_{D,T} / I_{D,100}$, where

(31) $I_{D,T} = I_{D,100}\left\{1 + \left[\left(\frac{1-R_{D,10}}{y_{100}-y_{10}}\right)(y_T - y_{100})\right]\right\}$ and

( ) $y_T = -\ln\left[-\ln(1-1/T)\right]$

T = Return Period, Years
R = Ratio
I_D = Intensity (For a given duration D), Inches/Hr.

Other parameters, such as discharge rate (Q) may be substituted for T.

Dairy Waste Pond Size Estimation

Kehoe

Dairy Waste Management System Evaluation

18-Aug-02

Rev 07/04/02

18-Aug-02

12:31 PM

Kehoe Dairy - Tim, Tom, Mike (Dairy ranch)

(415) 669-1698 (Telephone)

6150 Pierce Point Road, Inverness CA 94937 (Address)

Proposed Stall Barn Expansion - Future Animal Counts

1. Confined Animal Wastes

		No. of Animals	Weight 1000 lb. unit	Equiv Days confined	Gal/manure 000lb./day	Annual manure prod, Ac ft.	Notes. Adjust calcs in 3rd c
Milk Cows 1400 lbs	high string	260	364	319	14.8	5.27	6m confined
	low strings	270	378	319	14.8	5.48	6m 6h paddock
Dry Cows 1400 lbs.		22	30.8	180	10.0	0.17	6m confined
		23	32.2	180	10.0	0.18	6m confined
Yearling Heifers >900 lbs.		30	27	180	7.0	0.10	stall barn
Sm. Heifers 500-900 lbs.		100	70	180	4.8	0.19	dry lot around berms
Calves avg 300 lbs.		140	42	365	1.7	0.08	new east pens
Dairy Totals		845	944			11.47	

2. Unconfined Animal Wastes

Animal Group		No. of Animals	Weight 1000 lb. units	Equiv Days	Gallons Manure/ 1000lb./day	Annual Manure prod. Acre Feet	
Milk Cows 1400 lbs	high string	260	364.0	46	14.8	0.75	6mo 6h paddock
	low strings	270	378.0	46	14.8	0.78	6mo 6h paddock
Dry Cows 1400 lbs.		22	30.8	185	10.0	0.17	6m pasture
		23	32.2	185	10.0	0.18	6m pasture
Yearling Heifers >900 lbs.		100	90.0	365	7.0	0.70	dry lots;
Sm. Heifers 500-900 lbs.		100	70.0	185	4.8	0.19	dry lots;
Calves avg 300 lbs.		0	0.0	365	4.8	0.00	
On Site Totals		775	965			2.79	

3. Total Animal Waste

14.26 Acre Feet

4. Additions to the Confinement Waste Management System:

Notes:

24 Loads/yr sand 1.4 t/cy

0 Lb/day straw

2 % 50lb ration/day, milk strings at 40 lb/cu ft

Imported manure, whey, other

	Tons/Year	Acre Feet
Animal Bedding Makeup sand	480.0 tons	0.21
Animal bedding Straw/organic	0.0 tons	0.00
Damaged feed or silage	96.7 tons	0.11
Other	0 loads	0.00
Subtotal		0.32

5. Wash and Process Water Produced Annually

		Rate Gal/min	Use Hr/day	Gal/Day	Ac/ft per yr	Percent of Total
Milking System Wash Water				360	0.40	20.1
Milking System Backflush				0	0.00	0.0
Milk Tank Wash Water				100	0.11	5.6
Cow Wash Water	Gal H2O/cow	0.13		133	0.15	7.4
	Milkings/day	2				
Sprinkler Pen Water				0	0.00	0.0
Milking Parlor Wash Water		10	2.00	1200	1.34	66.9
Recycled wash water, per day		0	0.00	0	0.00	0.0
Vacuum Pump Water		0	10	0	0.00	0.0
Air Comp/Milk Cooler Water		0	10	0	0.00	0.0
Leaking troughs, other losses		0	24	0	0.00	0.0
Spring flows to manure storage		0	24	0	0.00	0.0
Flush System Added Water				0	0.00	0.0
			days/year	0		
Total Wash and Process Water				1793	2.01	100.0
				Gal/day	Acre Feet	

Section IV. Rain Water Additions to Waste System

Rainfall Data for Discretionary Design

Local average annual rainfall, inches	24.0	Local average per SCWA isohyetal map, rev June 83.	3.6	25-year, 24-hr storm inches @ avg*(3.8/25.5) = local/Petaluma.
10-year Wet-Winter Annual Rainfall, inches	35.8	10-year storm prorated based on 46 year Petaluma data with 25.5" avg annual and 38.0" 10-year wet winter (O'Connor, 2000).		

Estimate of Runoff from Dairy that Contributes to the Waste System

	Acres	Runoff Coefficient	Acre-feet	
Total Manured Surface Area	0.25	1.00	0.73	
Total Pond(s) Surface Area	2.75	1.00	8.20	
Watershed Area	0.55	0.40	0.66	
Crop/pasture	0.00	0.40	0.00	
Collection Area, Total	3.55		9.59	10-year Winter Storage Required
			1.08	25 year, 24-hour Storage Required

Pump size required to handle 25 year, 24-hour storm:

Hours pumped per day	Days pumped	Required Pump size, Gal/min	Pump Size OK? Pump period available? (Y/N; caps only)
12	1	479	N

Section V. Total Annual Waste Flows

Total System Evaluation

Estimate Annual Waste Storage Requirement at Dairy

	Acre Feet	Percent of Total	
On-Site Animal Waste	11.47	49.0	
Off-site additions to system (Bedding, feed, liquids)	0.32	1.4	
Wash and Process Water	2.01	8.6	
Manured-area Rainfall, 10-year wet winter	9.59	41.0	
Subtotal - Annual wastewater volume	23.38	100.0	baseline

Storage Reduction Adjustments

			Volume Reduction Acre-Feet	Adjusted Storage Volume Acre-Feet	% of Total	
Evaporation	Feet	0.50	1.38	22.01	94.1	Add
Ponds rain drained before use	Feet	1.2	2.75	19.25	82.3	4.30
Solids Separation		N	0.00	19.25	82.3	ac.ft.
Mech. Manure Separation? (Y/N; caps only)						if no
Slurry Transport	Gal/day	4200				drain or
Daily drawdown of sump or pond	Day/mo	10.0	1.54	17.71	75.7	slurry
independent of annual cleanout	Mo/yr	12.0				transport
Irrigation Disposal	Gal/min	200				
Daily drawdown of sump or pond	Hr/day	0.0				
independent of annual cleanout	Day/mo	0.0	0.00	17.71	75.7	
	Mo/yr	0.0				

Add 25-year, 24-hour storm runoff if insufficient pump capacity or cycle time	1.06	4.5
Total Annual Waste Flows Requiring Storage Capacity	18.77	80.3

Section VI. Evaluate Capacity of Existing Storage System

	Acre Feet
Waste Storage Capacity	
Design storage capacity of waste ponds. (from Areas worksheet)	18.77
Design storage capacity of other facilities. (add, if any)	
Total Storage Capacity (Add cells 19,21)	18.77
Waste Storage Capacity Reductions (Incomplete annual pond cleanout, etc)	0.00
Manure Handling and Storm Water Management Capability	
Working Storage Capacity (cell 3-cell 4)	18.77

Calculation indicates that:		**Total Capacity Available**
Storage Capacity is Satisfactory		
Excess Capacity Available:	**0.0** Acre-Feet	**18.8** Acre-Feet

Dairy Pond Size Estimation - Data Summary Sheet

Kehoe

Kehoe Dairy - Tim, Tom, Mike (415) 669-1696 18-Aug-02
6150 Pierce Point Road, Inverness CA 94937 12:31 PM

2. Unconfined Animal Wastes		2.79 acre feet			
1. Confined Animal Wastes		11.47 acre feet		**11.47**	acre-feet
3. Total Animal Waste		14.26 acre feet			
4. Additions to the Confinement Waste Management System:					
Animal Bedding	Makeup sand	0.21 acre feet			
	Straw/organic	0.00 acre feet			
	Other	0.00 acre feet		**0.32**	acre-feet
	Damaged feed	0.11 acre feet			
	Milking System Wash Water	0.51 acre feet			
	Milking System Backflush	0.00 acre feet			
	Cow Wash Water	0.15 acre feet			
	Sprinkler Pen Water	0.00 acre feet			
	Milking Parlor Wash Water	1.34 acre feet	1793 gal/day	**2.01**	acre-feet
	Recycled wash water, per day	0.00 acre feet			
	Vac Pump/Air Comp/Cooler	0.00 acre feet			
	Leaks/Springs	0.00 acre feet		**13.80**	af wastewate
	Flush System Added Water	0.00 acre feet		**59**	% of total

Rainfall Data for Discretionary Design	Acres	Coefficient	runoff, ac-ft	Design rain	Avg rain
				35.8	24.0
Manured surfaces	0.25	1.00	0.73		
Pond(s)	2.75	1.00	8.20		
Pond Watershed(s)	0.55	0.40	0.66		
Crop/Pasture areas	0.00	0.40	0.00		
Total Runoff				**9.59**	6.43
Collection Area,	3.55	na	9.59	ac ft	ac ft
Subtotal - Annual wastewater volume			Total:	**23.38**	20.23
Evaporation:				-1.38	-1.38
Solids separator:				0.00	0.00
Rainfall drawdown:				-2.75	-2.75
Slurry transport:	4200 gal/day	120 day/yr		-1.54	-1.54
Daily irrigation:	200 gpm	0 hr/yr		0.00	0.00
Adjusted storage volume, acre-feet per year:			-5.67	**17.71**	14.56
3.58 inches	25-year, 24-hr storm	Inches @ avg*(3.8/25.5) = local/Petaluma.			
	Pump size required to handle 25 year, 24-hour storm:			**1.06**	0.71
	12 hr/day				
	1 day/yr	479 gal/min			
Total Annual Waste Flows Requiring Storage Capacity				**18.77**	15.27

Waste Storage Capacity		
Design storage capacity of waste ponds.	18.77	acre-feet
Design storage capacity of other facilities.	0.00	acre-feet
Waste Storage Capacity Reductions	0.00	acre-feet
Working Storage Capacity	**18.77**	acre-feet

Calculation indicates that:		**Total Capacity**
Storage Capacity is Satisfactory		**Available**
Excess Capacity Available:	**0.0** Acre-Feet	**18.8** Acre-Feet

Runoff and Pond Areas Calculation Worksheet

18-Aug-02

Kehoe Dairy - Tim, Tom, Mike
6150 Pierce Point Road, Inverness CA 94937

Date: 18-Aug-02
Time: 12:34 PM

Measure individual areas or area combinations with tape measure and report in the space provided.

1. Exposed Manured Areas at Dairy

Includes feed lots, alley ways, holding corrals, sick pens, calf lots, compost piles, solids storage areas, outside loafing areas, and similar hardened or manured areas with 100% runoff to manure storage

Area	Width	Length	Sq Ft	Location Notes	Acres
1	100	107.0	10700	milk barn concrete corrals	0.25
2					0.00
3					0.00
4					0.00
5					0.00
6			0		0.00
			10700 Square Feet	0.25 Acres	Used in Sec IV, Cell 4 Cell 3 / 43560.

2. Manure Pit and Liquid Storage Pond Surface Areas

Includes wastewater ponds, manure pits, flush water recycle ponds, manure sumps, etc.

Note: When measuring the waste storage capacity of ponds, include the capacity of pit(s) and other collection facilities. If more than one pond is used, measure all ponds. Allow for two feet of freeboard in the last pond when making measurements.

Pond/Pit	Width	Length	Sq Ft	Avg depth	Capacity	Location Notes	Acres
1 main	80	210		6.5	2.50	manure pit/pond	0.00
1 freeboar	85	220	18700	2.0	0.86	pit 1 freeboard	0.43
2 overflow	50	80	4000	3.0	0.28	emergency overflow	0.09
3 north	190	206	39140	4.6	4.13	North pond, existing	0.90
4 north	150	387	58000	8.3	11.00	New Pond	1.33
			0		0.00		0.00
							0.00
			119840 Square Feet	2.75 Acres	18.77 Acre-feet		Used in Sec IV, Cell 3, Section VI Cell 1

3. Rainfall Collection Area Draining to Manure Storage Areas.

Includes tributary areas of clean water around barns and corrals that drain to manure ponds.

Area	Width	Length	Sq Ft	Location Notes	Acres
1	150	160	24000	hillside between barn and pit	0.55
2			0		0.00
3			0		0.00
4			0		0.00
5			0		0.00
			24000 Square Feet	0.55 Acres	Cell 3 / 43560 Used in Sec IV, Cell 4

4. Crop and Pasture Areas Draining to Manure Storage Areas

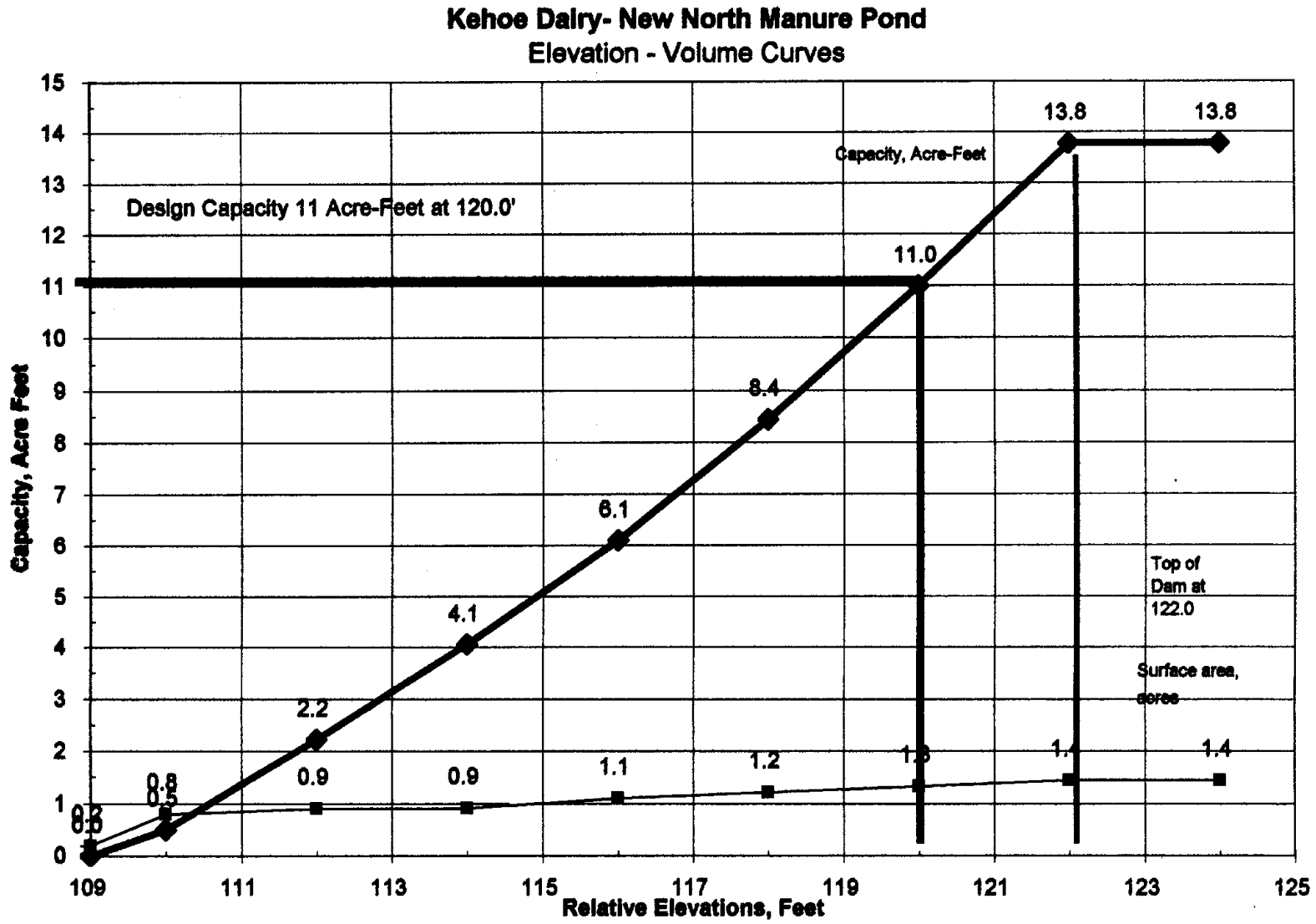
Includes tributary areas of clean water away from dairy that drain to manure ponds.

Area	Width	Length	Sq Ft	Location Notes	Acres
1			0		0.00
4			0		0.00
5			0		0.00
			0 Square Feet	0.00 Acres	Cell 3 / 43560 Used in SecIV, Cell 9

Stage-Capacity Data
Erickson Engineering Inc.
Data from CAD

File: c:\d\projects\kehoe\pondvol\K-ne(2)
Property: Kehoe Dairy
Project: North Manure Pond - New
Location: 6150 Pierce Point Road, Inverness CA
Date: 20-Aug-02 04:36 PM
Revised: 19-Aug-02

Elevation	Water Sq Ft	Avg SF	Volume Cu Ft	Cumulative Cu Ft	Water Acre-Feet	H2O Area, Acres	Water Gal x 10^6
124.0					13.8	1.4	
122.0	63130	60620	121240	600400	13.8	1.4	4.497
120.0	58110	55675	111350	479160	11.0	1.3	3.589
118.0	53240	50888	101775	367810	8.4	1.2	2.755
116.0	48535	44443	88885	266035	6.1	1.1	1.993
114.0	40350	39975	79950	177150	4.1	0.9	1.327
112.0	39600	37478	74955	97200	2.2	0.9	0.728
110.0	35355	22245	22245	22245	0.5	0.8	0.167
109.0	9135	0	0	0	0.0	0.2	0.000
106.0		0	0	0	0.0	0.0	0.000
104.0		0	0	0	0.0	0.0	0.000
102.0		0	0	0	0.0	0.0	0.000
100.0		0	0	0	0.0	0.0	0.000
98.0		0	0	0	0.0	0.0	0.000
96.0		0	0	0	0.0	0.0	0.000
94.0		0	0	0	0.0	0.0	0.000
92.0		0	0	0	0.0	0.0	0.000
	347455	311323					


Kehoe Dairy- New North Manure Pond
Elevation - Volume Curves
Capacity, Acre Feet
Relative Elevations, Feet
Design Capacity 11 Acre-Feet at 120.0'
Capacity, Acre-Feet
Top of Dam at 122.0
Surface area, acres
13.8
13.8
11.0
8.4
6.1
4.1
2.2
0.9
0.9
1.1
1.2
1.4
1.4
0.8
0.5
0
1
2
3
4
5
6
7
8
9
10
11
12
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14
15
109
111
113
115
117
119
121
123
125

Rev 7/04/02 **Nutrient Budgeting Worksheet** Nbudget-kehoe 4-Jul-02 12:36 PM

This worksheet is intended to provide guidance for nutrient budgeting for management of manure produced by animals in both confined and unconfined conditions. It will partially fulfill facilities management plans as recommended by regulatory agencies.

Complete the Producer and Area worksheets prior to entering nutrient bugeting information. Provide inputs as required in empty green-shaded boxes in the Nutrient Bugeting worksheet. Calculation results are shown in non-shaded boxes.

Nutrient budgeting may include confined or unconfined animals, irrigated and non-irrigated land, fertilized or non-fertilized inputs, and may use lab or handbook data for stored manure nutrient values. **Several runs of this computer spreadsheet worksheet will be needed to evaluate confined animal manures, unconfined animal manures, and individual fields, either on-site or off-site, because of the large number of possible nutrient input combinations.** Take care when evaluating individual fields to include all inputs, and to eliminate duplicate accounting with such items as animals pastured elsewhere or fertilizer and irrigation water used elsewhere. Total ranch nutrient budgeting can be accomplished using total headcounts, acreages, etc., and will represent average conditions rather than site-specific conditions.

Results are based on a large number of input assumptions, and represent general nutrient budgeting trends, rather than an exact detail accounting of site-specific conditions. Detailed assessments will require concentration sampling and quantity measurements of soil, forage, crops, irrigation water, stored manure, and other inputs and outputs to the nutrient input, waste management, and nutrient consumption systems.

Section I. Producer Information

Kehoe Dairy - Tim, Tom, Mike
6150 Pierce Point Road, Inverness CA 94937 (415) 669-1696

Land Areas	On-Site Acres	Off-Site Acres	Total Acres
Total Property	1240		1240
Pasture Lands Irrigated or dry	900 3	6	900
All Crop Lands	180 2	5	180
Vineyard or Non-Dairy	120		120
Housing, corrals barns, other non-producing	40 1	0 1a	40
	Acres	Acres	Manure disposal Acres
Total Crop and Pasture	1080 4	0 7	1080 8
	(add cells,2, 3)	(add cells 5,6)	(add cells,4,7)

Section II: Pasture and Crop Nutrient Demand

Table 1. Plant Food Utilization by Various Crops

Total uptake in harvested portion. Reference: Table 4.1, Western Fertilizer Handbook

	Crop	Yield	Pounds per Acre N	P_2O_5	K_2O
Field Crops	Corn - grain	5t/180bu	240	100	240
	Corn - silage	30t	250	105	250
	Grain sorghum	4t / 150bu	250	90	200
	Oats	1.6t/100bu	115	40	145
	Wheat	3t/100bu	175	70	200
	Barley	2.5t / 100bu	160	60	160
Fruit and Nut Crops	Apples	15t	120	55	215
	Grapes	15t	125	45	195
Forage Crops	Alfalfa	8t	480	95	480
	Bromegrass	5t	220	65	315
	Clover-grass	6t	300	90	360
	Orchardgrass	6t	300	100	375
	Sorghum-sudan	8t	325	125	475
	Timothy	4t	150	55	250
	Vetch	7t	390	105	320

Note: These parameter values may be adjusted as desired to best match existing site conditions.

Change numbers in this table to adjust nutrient demands to reflect soils, slope, aspect, rainfall, other parameters affecting plant vigor and nutrient demand.

Coastal Dryland Pasture	200	80	175
Irrigated Pasture	275	90	300

Section III: Nutrient Composition of Manure

Nutrient concentration of manure depends on animal species and age, feed materials and additives, source of manure, storage method, length of storage, rainwater dilution, disposal method, and other factors. The most accurate nutrient budgeting estimates will be obtained if lab samples for nutrient concentration are taken from the storage area. A composite sample from several surface locations and depths within the storage is required for a representative value. The average table values shown from USDA-SCS Ag Waste Management Field Handbook are used for calculations if you do not provide site-specific nutrient concentrations.

Table 2. USDA-NRCS Ag Waste Handbook
Nutrients, lb/day/1000lb of animal

Nutrient Parameter	milking	dry	heifer
Nitrogen, N:	0.45	0.36	0.31
Phosphorous, P:	0.07	0.05	0.04
Potassium, K:	0.26	0.23	0.24
Copper, Cu:		22	

Table 3. Commercial Laboratory Analysis
of your stored liquid manure

	If available, enter data here	
Parameter	Milligrams/liter	Equivalent lb/gal
Nitrogen, N:		0.00000
Phosphorous, P:		0.00000
Potassium, K:		0.00000
Copper, Cu:		0.00000

Section IV. Annual Production of Animal Waste for All Livestock

Nutrient quantities stored in containment facilities are estimated in one of two ways:

1) USDA handbook N-P-K values are used with confined animal counts and manure production estimates obtained from the **Producer** worksheet.
2) If commercial lab analysis data for N-P-K is entered above, nutrient quantities are based on the lab concentration data times the pond storage volume obtained from the **Producer** worksheet.

Note that total nutrient quantity estimates in storage facilities may be significantly different using the two different approaches. Lab data from the storage pond will tend to be most accurate. This is because factors affecting nutrient concentration are taken into account, including seasonal dilution, process and wash water, actual manure quantities collected, external inputs to storage, changes during storage, and similar factors. Wide variation between individual facilities can be expected.

1. Handbook Method Animal counts from the companion **Producer worksheet** are multiplied by the appropriate table values for N, P, and K above to determine nutrient production.

Table 4. Unconfined Animal Nutrients
Production based on Handbook Values

	Unconfined Cubic Feet	Total Pounds of Nutrients N	P	K
Milk Cows	32816	7473	1163	4318
1400 lbs.	34078	7761	1207	4484
Dry Cows	7607	2051	285	1311
1400 lbs.	7953	2145	298	1370
Yearling Heifer >900 lbs.	30701	10184	1314	7884
Sm. Heifers 500-900 lbs.	8299	4015	518	3108
Calves <500 lbs	-	-	-	-
Calves avg 300 lbs.	121455	0	0	0
On Site Totals	121455	33628	4785	22475

Table 5. Confined Animal Nutrients
Production based on Handbook Values

Confined Cubic Feet	Total Pounds of Nutrients N	P	K
229711	52314	8138	30226
238546	54326	8451	31388
7402	1996	277	1275
7738	2087	290	1333
4542	1507	194	1166
8075	3906	504	3024
3479	4752	613	3679
-	-	-	-
499494	120887	18467	72092

2. Lab Data Method: Laboratory nutrient analysis of existing storage liquid is multiplied by existing pond storage volume to estimate total nutrient quantities in storage. Only for CONFINEMENT manure.

Note: If ponds are pumped to maintain adequate winter storage, or if storage encroaches into freeboard requirements, the working storage capacity is not a true measure of animal manure production and storage. Indicate additional storage in the box provided to account for total annual production.

Working storage capacity, from Producer Worksheet, Section VI: Acre-feet	Storage Additions, Acre-feet
-0.31	1.54

Cells G130+g134-F159 main sheet

Table 6. Confined Animal Manure Storage Nutrients

Based on lab sampling data, lb.		
N	P	K
0	0	0

3. Calculation Method for Acreage Requirments:

The remainder of this worksheet is used to determine the acres required for consumption of N - P - K nutrients in keeping with good crop management practices. Application rates consistent with crop uptake needs will maximize economic benefits of applied manures and will reduce chance of impairing surface water runoff quality.

Area requirement calculations are based on total nutrients produced. Indicate in the box below if the calculations for stored liquid and solid manures should be based on : 1 = Handbook values, or 2 = Lab Data values. Unconfined animal nutrient values are based on handbook information, because lab data for grazed animal manures is difficult to obtain.

CONFINED ONLY Animal Manure Nutrient Calculation Method 1

1 = Handbook Values
2 = Lab Data Values

Section V: Manure Nutrient Quantity Adjustments

1. Manure Storage Method

Nutrient losses from manure occur during collection, storage, application, and after land application. Losses can vary widely, depending on collection method, collection frequency, temperature, precipitation, type of handling system, duration, type, and location of storage, and other factors.

About half the N in fresh manure is inorganic, and subject to significant losses.
The table from Oregon State University publication EC1094 provides an estimate of NPK retained by various storage systems. Lab nutrient analyses of manure take these storage losses into account. Use these adjustment values in Table 14 and Table 16 below.

Table 7. Percentage of Original Manure Nutrient Content Retained by Storage System

	N	P	K
Daily Spread	80	90	90
Dry, under roof	70	90	90
Earth storage	55	60	70
Lagoon/flush	30	40	60
Open lot	60	70	65
Pits under slats	75	95	95
Scrape/storage tank	70	90	90
None (grazing)	100	100	100

2. Manure Spreading Method

Nitrogen nutrient losses from manure can occur during spreading (Fresh manure odor is mostly volatized ammonia). Essentially all phosphorus and potassium applied will be available to the crop. The table from OSU publication EC1094 summarizes percent nutrient delivered to cropland and available for plant uptake, based on application and preutilization losses. Use these adjustment values in Table 14 and Table 16 below.

Table 8. Percentage of Original Manure Nutrient Content Delivered to Crop and Available for Uptake

	N	P	K
Injection	95	100	100
Broadcast	80	100	100
Broadcast/cultivate	95	100	100
Sprinkling	75	100	100
Grazing	85	100	100

Section VI: Additional Nutrient Inputs

1. Commercial Fertilizer

Many ranchers provide supplemental fertilizer to pasture or silage crops, on an annual or other intermittent basis. These nutrients should be accounted for in a complete nutrient budget. Fertilizer may be applied in pastures where unconfined animals are grazed, in irrigated pastures, where manure is disposed, and in crop areas. This section estimates total nutrients available based on the fertilizer formulation used, the application rate, and the application frequency. Fertilizer composition data is from Western Fertilizer Handbook, Table 5-5.

Table 9. Nutrient Value of Selected Commercial Fertilizers

Western Fertilizer Handbook Table 5-5 Fertilizer Formulation	Total Nitrogen N%	Available Phosphoric Acid P_2O_5%	Water-soluble Potash K_2O%
Ammonium nitrate	34		
Monoammonium phosphate	11	48	
Ammonium phosphate 1	13	39	
Ammonium phosphate 2	16	20	
Ammonium phosphate 3	27	12	
Diammonium phosphate	17	47	
Ammonium sulfate	21		
Anhydrous ammonia	82		
Aqua ammonia	20		
Sodium nitrate	16		
Urea	45		
Urea ammonium nitrate	32		
Single superphosphate		18	
Triple superphosphate		45	
Phosphoric acid		53	
Superphosphoric acid		80	
Potassium chloride			61
Potassium nitrate	13		44
Potassium sulfate			51
Sulfate of potash-magnesia			22

Indicate tons of fertilizer applied, area covered in acres, and how many years between applications for the commercial fertilizers noted. Formulations in Table 9 are used to estimate NPK application rates by fertilizer classification, using multipliers for elemental nutrients NPK.

You will need to rerun the spreadsheet to determine effects on individual fields, if all fields are not treated the same. Entering two kinds of fertilizer on a single field will result in acreage duplication in the Table 10 summary and errors in the nutrient budget summary in Table 14.

For simplicity, fertilizer nutrient values are included in both confined and unconfined animal manure disposal area evaluations, further down the spreadsheet. You will need to rerun the spreadsheet to individually evaluate confined and unconfined manure disposal areas, if both are not treated with equal amounts of commercial fertilizer.

Table 10. Commercial Fertilizer Application

Fertilizer Formulation	Fertilizer Application Data: Amount applied Tons	Area covered Acres	Application frequency Years	Nutrient Summary Pounds/acre/year: Total Fertilizer	N	P	K
Ammonium nitrate				0	0		
Monoammonium phosphate				0	0	0	
Ammonium phosphate 1				0	0	0	
Ammonium phosphate 2				0	0	0	
Ammonium phosphate 3				0	0	0	
Diammonium phosphate				0	0	0	
Ammonium sulfate				0	0		
Anhydrous ammonia				0	0		
Aqua ammonia				0	0		
Sodium nitrate				0	0		
Urea				0	0		
Urea ammonium nitrate				0	0		
Single superphosphate				0		0	
Triple superphosphate				0		0	
Phosphoric acid				0		0	
Superphosphoric acid				0		0	
Potassium chloride				0			0
Potassium nitrate				0	0		0
Potassium sulfate				0			0
Sulfate of potash-magnesia				0			0
Subtotals:		0	Acres	0	0	0	0

Average pounds per acre per year

2. Irrigation Water

Some dairy ranches utilize reclaimed water for irrigation purposes. This water may contain significant amounts of nutrients that must be included in the nutrient budget in order to obtain accurate results. This section estimates total nutrient availability based on lab data for the water and total application rate, in inches of water per year.

Enter nutrient concentrations in mg/l for N, P, and K. If nutrient concentrations are reported in other units, provide appropriate conversions before entering data. For example, multiply P_2O_5 by .4365 to obtain P and multiply K_2O by .8301 to obtain K.

For simplicity, irrigation water nutrient values are included in both confined and unconfined animal manure disposal area evaluations, further down the spreadsheet. You will need to rerun the spreadsheet to individually evaluate confined and unconfined manure disposal areas, if both are not treated with equal amounts of irrigation water.

Irrigated Area: 0 Acres per Year

Irrigation application: 0 inches per acre/year

Table 11. Irrigation Water Nutrients

Commercial Laboratory Analysis of your irrigation water (City of Santa Rosa typical data, 1995)

Nutrient Parameter	If available, enter data here: Milligrams/liter	Equivalent lb/gal
Nitrogen, N:	20.0	0.00017
Phosphorous, P:	1.2	0.00001
Potassium, K:	2.0	0.00002
Copper, Cu:	0.02	0.00000

Table 12. Irrigation Water Nutrient Application Rate

Based on lab concentrations and inches/year

	Pounds/acre/year
N:	0
P:	0
K:	0
Cu:	0.0

Section VII: Manure Management on Available Acreage

1. Unconfined Animals on Seasonal Pastures:

Unconfined animals are grazed on pasture or crop stubble, with manure spread naturally by the animals. All manure nutrient content is retained by the system, and the only losses are due to denitirfication prior to plant uptake. Evaluate nutrient budgeting for unconfined animals by comparing annual NPK production to recommended NPK uptake for forage production on available acreage.

Indicate grazed acreage in Table 13 below. Nutrient demand is estimated based on published values in Table 1 above. Compare your yield values to those stated in Table 1. If your yields are significantly higher or lower, adjust the Table 1 nutrient demand values up or down to reflect actual crop demand based on local productivity.

Table 13. Grazed acreage for unconfined animals.

	On-Site Acres		Nutrient Demand, Pounds N	P_2O_5	K_2O
Field Crops					
Corn - grain			0	0	0
Corn - silage			0	0	0
Grain sorghum			0	0	0
Oats			0	0	0
Wheat			0	0	0
Barley			0	0	0
Fruit and Nut Crops					
Apples			0	0	0
Grapes			0	0	0
Forage Crops					
Alfalfa			0	0	0
Bromegrass			0	0	0
Clovergrass			0	0	0
Orchardgrass			0	0	0
Sorghum-sudan			0	0	0
Timothy			0	0	0
Vetch			0	0	0
Dryland Pasture	400.0		80000	32000	70000
Irrigated Pasture			0	0	0
Subtotals:	400.0	acres pastured	80000	32000	70000

Table 14. Unconfined Animal Nutrient Balance Estimation

Note: This evaluation for grazed pasture areas is based on **handbook nutrient values**, since lab data for animal-distributed manure is difficult to obtain. It assumes that common acreage is used for livestock pasture and application of both commercial fertilizer and irrigation water. Unconfined animal counts are reported in the **Producer** worksheet. Return to previous sections if necessary to adjust animal counts, acreages, irrigation application, and commercial fertilizer application so that a valid evaluation may be made for pastured areas where unconfined animals are kept. Acre counts for Pastured, Irrigated, and Fertilized should be the same. Acres used for nutrient consumption should be equal to or less than total available on-site and off-site acres.

Acreage Check:	400.0 Pastured acres (Table 14)	1080	On-site acres (Section 1)
	0 Irrigated acres (Table 11)	0	Off-site acres (Section 1)
	0 Fertilized acres (Table 10)	1080	Total acres (Section 1)

1. Nutrient Inputs:

	N	P	K	
Table 4: NPK Production, lb:	33628	4785	22475	lb/yr
Table 7: Storage adjustment (grazing)	1.00	1.00	1.00	
Table 8: NPK delivery adjustment:	0.85	1.00	1.00	

Revise these adjustments to match your operation.

Estimated manure application rate by grazing animals:
9 tons/acre Based on Table 5 animal production quantities, pastured acres.

Available from manure:	Manure NPK available , lb:	28584	4785	22475	lb/yr
	Manure NPK available , lb/ac:	71	12	56	lb/ac
External Inputs:	**Table 10:** Comm'l Fert, lb NPK/ac:	0	0	0	lb/ac
	Table 12: Irrig Water, lb NPK/ac	0	0	0	lb/ac
	Subtotal Inputs:	71	12	56	lb/ac

2. Crop Nutrient Demands:	N	P	K	
Adjustment factor for elemental nutrient:	1.0000	0.4365	0.8301	
Table 13: Adjusted NPK requirement, lb:	200	35	145	lb/ac

3. Nutrient Balance:				
Subtotal Manure, Fertilizer, Irrigation Inputs, lb/yr:	71	12	56	lb/ac
Subtotal Crop and Pasture Consumption, lb/yr:	200	35	145	lb/ac
Difference, Inputs minus Outputs, lb/yr:	-129	-23	-89	lb/ac

4. Nutrient Application Recommendations Analysis based on total pastured acres.

71 lb/ac N applied. Additional N permissible.	129 lb/ac additional N permissible.
12 lb/ac P applied. Additional P permissible.	23 lb/ac additional P permissible.
56 lb/ac K applied. Additional K permissible.	89 lb/ac additional K permissible.

2. Confined Animal Manure Disposal on Remote Fields:

Manure from confined animals is normally applied to pasture or crop stubble. The nutrient budget evaluation may be completed using either handbook values or lab analysis values. Manure nutrient quality may be adjusted for storage losses and application losses. Evaluate nutrient budgeting for seasonally-confined animals by comparing annual N-P-K production in storage to recommended N-P-K uptake for forage production on disposal acreage.

Table 15. Manure disposal acreage for confined animals.

	On-Site Acres		Nutrient Demand, Pounds N	P_2O_5	K_2O
Field Crops					
Corn - grain			0	0	0
Corn - silage			0	0	0
Grain sorghum			0	0	0
Oats			0	0	0
Wheat			0	0	0
Barley			0	0	0
Fruit and Nut Crops					
Apples			0	0	0
Grapes			0	0	0
Forage Crops					
Alfalfa			0	0	0
Bromegrass			0	0	0
Clovergrass			0	0	0
Orchardgrass			0	0	0
Sorghum-sudan			0	0	0
Timothy			0	0	0
Vetch			0	0	0
Dryland Pasture	350.0		70000	28000	61250
Irrigated Pasture			0	0	0
Subtotals:	350.0	acres spread	70000	28000	61250

Table 16. Confined Animal Nutrient Balance Estimation

Note: This evaluation for pasture and crop areas assumes that common acreage is used for stored manure disposal and application of both commercial fertilizer and irrigation water. Confined animal counts are reported in the Producer worksheet. Return to previous sections if necessary to adjust animal counts, confinement season, acreages, irrigation amounts, and commercial fertilizer amounts so that a valid evaluation may be made for pasture or crop areas where confined animal manures are disposed. Acre counts for Pastured, Irrigated, and Fertilized areas should be the same. Acres used for nutrient consumption should be equal to or less than total available on-site and off-site acres.

Acreage Check:	350.0 manure disposal acres	(Table 15)	1080 On-site acres	(Section 1)
	0 irrigated acres	(Table 11)	0 Off-site acres	(Section 1)
	0 fertilized acres	(Table 10	1080 Total acres	(Section 1)

Handbook values used for Liquid Manure nutrient estimation.

1. Nutrient Inputs:

	N	P	K	
Table 4: NPK Production, lb:	120887	18467	72092	lb/yr
Table 7: Storage Adjustment (Earthen):	0.55	0.60	0.70	
Table 8: Delivery Adjustment (Broadcast):	0.80	1.00	1.00	

Revise these parameters to match your operation.
(All storage adjustments = 1.00 for lab data approach)

Required manure application rate for disposal:
3 tons/acre Based on Table 5 animal production quantities, spread acres.

		N	P	K	
Available from manure:	Manure NPK available , lb:	53190	11080	50464	lb/yr
	Manure NPK available , lb/ac:	152	32	144	lb/ac
External Inputs:	**Table 10**: Comm'l Fert, lb NPK/ac:	0	0	0	lb/ac
	Table 12: Irrig Water, lb NPK/ac	0	0	0	lb/ac
	Subtotal Inputs:	152	32	144	lb/ac

2. Crop Nutrient Demands:	N	P	K	
Adjustment factor for elemental nutrient:	1.0000	0.4365	0.8301	
Table 15: Adjusted NPK requirement, lb:	200	35	145	lb/ac

3. Nutrient Balance:				
Subtotal Manure, Fertilizer, Irrigation Inputs, lb/yr:	152	32	144	lb/ac
Subtotal Crop and Pasture Consumption, lb/yr:	200	35	145	lb/ac
Difference, Inputs minus Outputs, lb/yr:	-48	-3	-1	lb/ac

4. Nutrient Application Recommendations Analysis based on total manure disposal acres.

152 lb/ac N applied. Additional N permissible.	48 lb/ac additional N permissible.
32 lb/ac P applied. Additional P permissible.	3 lb/ac additional P permissible.
144 lb/ac K applied. Additional K permissible.	1 lb/ac additional K permissible.

Table 17. Fertilizer Economic Value

Relative value of animal manure and irrigation water nutrients may be determined by comparison to commercially available bulk grannular fertilizer. Enter comparative retail costs for Ammonium sulfate (16-20-0)and for Potassium Chloride KCl (0-0-60) below for use as benchmark values. Handling and spreading costs vary for each producer and are not considered in the evaluation.

Animal manures as fertlizer provide additional intangible benefits such as micronutrients, microbial populations, and organic matter for soil building.

1. Benchmark economic values Enter current fertilizer costs

Ammonium Sulfate (16-20-0), bulk grannular delivered to ranch:	$ 200.00	per ton
Potassium Chloride (0-0-60), bulk grannular delivered to ranch:	$ 270.00	per ton

	N	P	K		
Equivalent value, $/lb:	$ 0.0160	$ 0.0087	$ 0.0672		
Unconfined animal manure	$457	$42	$1,511	$2,010	unconfined
Confined animal manure	$851	$97	$3,393	$4,341	confined
Irrigation water	$0	$0	$0		
Applied Nutrient Values:	$1,308	$138	$4,905	Total Values	

Total Applied Nutrient Value: $6,351

This Nutrient Budgeting worksheet was developed to assist dairy ranch operators in evaluating waste management facilities and non-point source nutrient loading on their property, in order to better manage manures and protect fresh water resources. Developing and implementing a waste management plan based on appropriate management strategies will aid in preventing code violation through discharge of nutrient-laden materials into the waters of the region. The plan is the effort of the Gold Ridge Resource Conservation District, in cooperation with the University of California Cooperative Extension, Sonoma Marin Animal Waste Committee, North Coast Regional Water Quality Control Board, Natural Resource Conservation Service, and Western United Dairymen. The plan is a self-monitoring aid and may be used by anyone. The document may be copied and used freely. No warranty is expressed or implied and the authors are not responsible for facilities construction or operation or management decisions made on the basis of program outputs. Credit to the authors will be appreciated. L.R. Erickson Ph.D. Gold Ridge RCD.